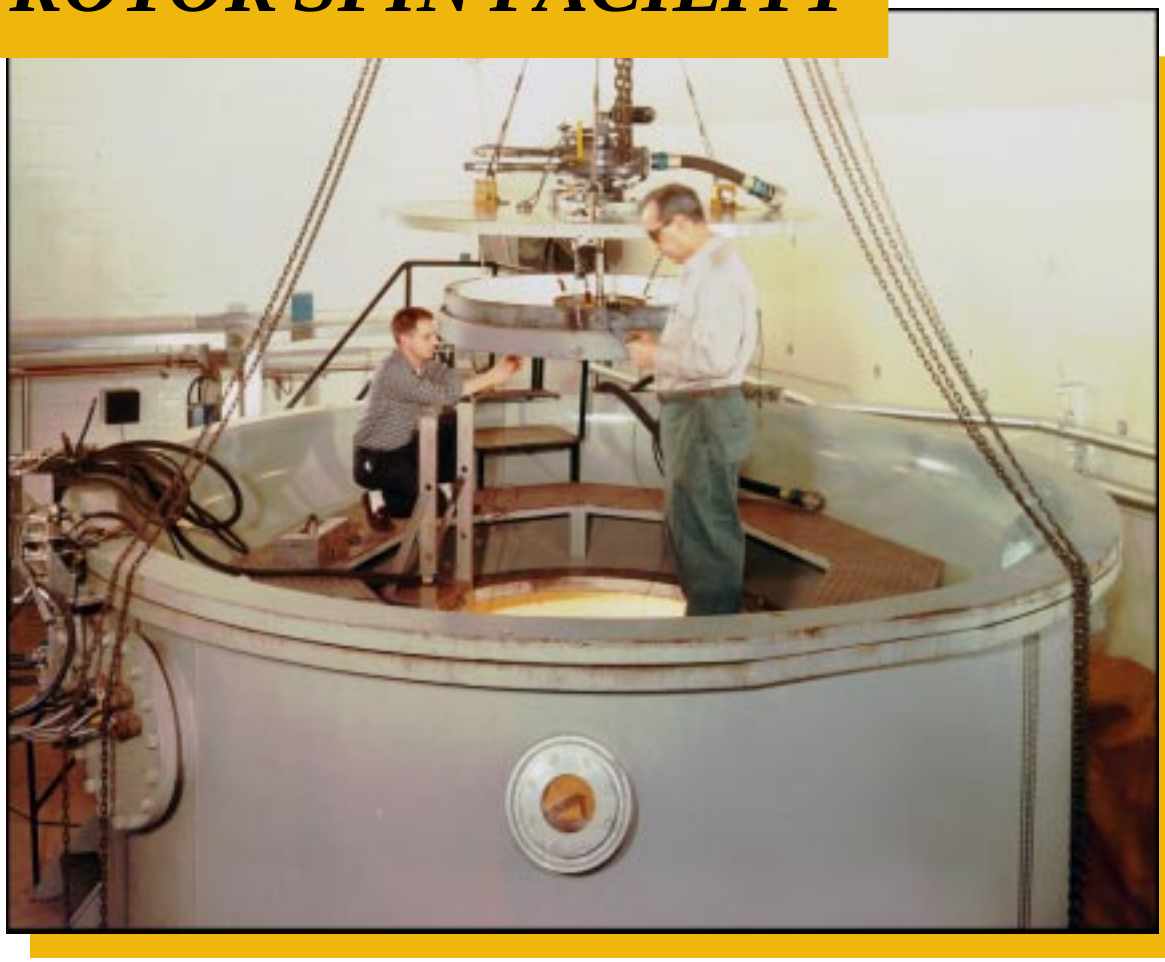
ROTOR SPIN FACILITY



The Rotor Spin Facility (RSF) provides experimental support for research, development and evaluation programs that pertain to rotor (engine disks and blades) structural integrity, durability, life management and burst protection. In this facility, under simulated engine conditions, inexpensive and expeditious component testing is conducted to evaluate, develop and optimize rotor designs.

PROVIDES DOD WITH SAFER & MORE EFFICIENT AIRCRAFT COMPONENTS & SYSTEMS

The Rotor Spin Facility (RSF) spins rotating turbomachinery up to design speeds effort to determine the service life of parts. This testing is done under vacuum to preclude heating and air-load effects. Testing of this kind has become exceedingly important due to ever-increasing rotational speeds, advanced rotor design of new engines, and concerns for "aging" engines used throughout the DoD. The Navy/Air Force/Army Aircraft Engine Development Teams represent the sponsors of this testing arena.

Testing Capabilities:

The RSF supports experimental testing in the following areas:

- Engine rotor stress analysis
- Rotor structural integrity investigations
- Blade and disk containment evaluation
- Low-cycle fatigue (LCF) spin testing of air-breathing engine rotating components
- Over-speed tests for qualification and release to production
- Evaluation of exploratory and advanced developmental concepts
- Verification of component life prediction methodologies developed by engine manufacturers
- Blade excitation capabilities for validation of high-cycle fatigue (HCF) phenomena (currently under development - projected to be installed sometime in the year 2000)

Test Equipment/Instrumentation Capabilities:

This facility is comprised of four vertical vacuum spin chambers of varying size which are capable of accommodating a wide range of rotor assemblies. Each spin chamber is equipped with a removable lid providing for expedient drive turbine and test vehicle assembly. The chamber lid and wall will also accommodate various drive turbines and instrumentation sensors. Other component accessories, such as high-speed cameras, can be adapted to the spin chamber wall as well. A typical spin chamber consists of an outer cylindrical steel shell fabricated with several ports, an air space, an inner laminated steel liner, and an inner containment chamber liner. Inner containment chamber liner materials consist generally of either wood, lead, or aluminum. Together, the outer shell and inner liners are capable of absorbing over 8 million ft-lbs of energy generated from rotor burst fragments. The largest spin chamber boasts dimensions of 106 inches in working diameter and 72 inches in height.

The following are the more salient features of this testing facility:

- Four (4) spin chambers with inner diameters of 106, 59, 45, and 24 inches
- Air turbine drive systems that generate rotor speeds up to 150,000 rpm
- A 250 hp high torque/low speed electric drive (3750 rpm)
- State-of-the-art diagnostics instrumentation system capable of performing vibration diagnostics and in-chamber balancing
- Heating systems capable of producing rotor temperatures, gradient or isothermal, up to 2000 ^{0}F
- High-speed slip rings that can transfer millivolt signals at 100,000 rpm through 28 channels and at 50,000 rpm through 100 channels
- Automated cyclic control systems which provide unattended 24-hour operation
- Vacuum and air pressure capabilities suitable for multi-chamber operation
- Real-time automatic recording, processing and graphics of multiple parameter data up to 60 channels per chamber
- High-speed photo instrumentation systems capable of taking 200 sequential photographs at a rate of 35,000 frames per second.

Unique Features/Accomplishments

- LCF testing of the F/A-18 E/F high pressure compressor (HPC) detected its balancing ring design flaw causing the unexpected failure of the HPC.
- Completed Over-speed and LCF testing on the F/A-18 E/F low pressure turbine, compressor, and fan for qualification and release to production.
- Completed LCF testing to extend the life limit of the T45 low pressure turbine (LPT) from 14,9000 to 18,500 cycles and alleviate a potentially negative fleet impact. Spin testing had also identified a critical location on the LPT predicted by 3-D finite element analysis and modeling.
- Validated the Probabilistic Rotor Design System (PRDS) methodology by performing LCF testing on seeded model disks. Test results are being used to refine the PRDS methodology.
- Successfully determined the minimum acceptable grease pack weight/ percentage of the bearings installed on the generator-regulator used in the Tomahawk Cruise Missile. Test results are also being used to assess operating time and high temperatures encountered during acceptance of the generator-regulators.
- Completed the test program and identified the state-of-the-art containment ring materials which could provide suitable containment and/or isolation from the worst case small turbine engine rotor failure hazard.

For more information contact the Rotor Spin Facility at the Naval Air Warfare Center Aircraft Division, Patuxent River, MD, at 301-757-0466.